THE JOURNAL OF INDUSTRIAL HYGIENE

VOLUME XI APRIL, 1929 NUMBER 4

THE COST OF FREE ADVICE. TUBERCULOSIS IN AN INDUSTRIAL GROUP*

E. W. PHILLIPS, M.D.

Phoenix, Ariz.

ONE of the greatest obstacles to the effective control of tuberculosis is found in the late diagnosis of the disease. The reason for delay in diagnosis may be the ignorance or the indifference of the patient, the cost of medical service, or the diagnostic failure of the physician. This paper presents briefly the results of the study of a small group of tuberculous patients whose cases, in spite of conditions which would appear to favor prompt diagnosis and favorable outcome, nevertheless were diagnosed late.

The group was selected for study from a much larger number of sanatorium patients because our information concerning their mode of life, the medical facilities available to them, the cost of their treatment, and their condition after discharge is unusually complete. These patients were the tuberculous employees of one division of a railroad and were treated during the past four years. We received them, without selection, shortly after their tuberculosis was diagnosed. They constituted for the period of time under consideration the tuberculosis problem of a rather stable industrial community of some 15,000 workers—a community none the less though it happens to be stretched along some hundreds of miles of right of way. They were all white, and either skilled workmen or office workers. The company employs for common labor mostly Mexicans, with some negroes and Japanese, and the twenty-eight of these who fell ill of tuberculosis during the four-year period under consideration are not included in this analysis. They are, however, included in estimating the annual tuberculosis admission rate, which is approximately one case to every 800 persons employed.

*Received for publication Jan. 31, 1929.

These patients lived and worked in a good climate. Being railroad men, they earned an adequate living wage, and could afford decent quarters and ample food. They were all members of a hospital association, to which they contributed a small sum from their monthly pay; they were entitled to consult the company doctors without charge, they received certain medicines free, and, if tuberculous, their sanatorium bills were paid for a period varying with the length of their employment. The railroad company takes an active interest in this hospital association and helps its operation in many ways. Sick men get free transportation, their jobs are held open for a reasonable time, or easy work is found for them, if necessary, when they recover. There is a well-equipped central hospital where diagnostic laboratory work is done, also without charge. If the patient is willing to accept institutional treatment, his diagnosis is followed by transfer to the sanatorium within a short time unless his condition forbids the journey. The expense of medical service, therefore, did not delay diagnosis and treatment in any case of this series.

This corporation has a good medical staff. Its local surgeons, selected of course for their surgical ability, are among the best in their respective communities. It carries on a safety first campaign for the prevention of accidents, and is considered to be, in general, efficient.

During the four years covered by this analysis, thirty-eight tuberculous employees were discharged from treatment. Their classification when received at the sanatorium, according to the National Tuberculosis Association standards, was:

	Number	*Per Cent.*
Far advanced.....	33	87
Moderately advanced....	3	8
Minimal.....	2	5

There are now in the sanatorium under treatment six patients, and five of these are far advanced—practically the same proportion. Of this whole group of forty-four patients, then, thirty-eight, or more than 86 per cent., were far advanced in their disease when admitted; fifteen were classed as far-advanced "C," with "severe symptoms: marked impairment of function, local or constitutional;" which implies an unfavorable prognosis.

The duration of treatment of these far-advanced patients varied from less than 1 month (when death occurred) to 27 months, and it averaged 10.3 months. Of the thirty-three far-advanced patients, three, or 9 per cent., died in the sanatorium; ten, or 30 per cent., were discharged unimproved; twelve, or 36 per cent., were improved, and the remaining eight, or about 24 per cent., were quiescent, apparently arrested or arrested.

The follow-up of these thirty surviving far-advanced patients, from one to three years after their discharge, is interesting. Two (one was unimproved when discharged) have not been traced. Eleven, or about 37 per cent. of the number, have died; eight of these were unimproved when they left the sanatorium. Six are living but are still under treatment. The remaining eleven report themselves able to work, but only seven of these are working for the company

that formerly employed them. Excluding one suicide, we know that thirteen out of thirty-three far-advanced patients have died of tuberculosis within four years after their admission—a mortality of nearly 40 per cent., as compared to eleven, or 33 per cent., who are able to work, and but seven of these are back at their former jobs. It cost the hospital association about $32,300 to treat the far-advanced cases; or $4,600 for each trained employee returned to his work.

In striking contrast are the results obtained in the treatment of the three moderately advanced patients in this series. After a period of hospitalization averaging 11.3 months, they were discharged as arrested or apparently arrested; two are now working for the company, the third is about to resume work. It cost about $1,050 each to repair these men. Similarly, excellent results were obtained with the two early cases. They were returned to work after a few months of treatment, apparently arrested, at an average cost of $450 each.

Clearly, an early diagnosis was of great advantage to employer and employees alike. These people were of good average intelligence, they had an organization designed to protect their health, and its services were to be had for the asking. Why then was the recognition of pulmonary tuberculosis so long delayed? A study of the histories of the far-advanced cases returns at least a partial answer. One necessarily makes allowance for some inaccuracy on the part of the patient in relating the onset of his illness; nevertheless, the information in the mass is probably as accurate as any other testimony. In obtaining these histories care was taken to avoid leading questions. When possible, the narrative has been checked up from sources other than the patient, and as a rule it has been found to be substantially correct.

Three patients admitted that they came to the Southwest to obtain the benefit of the climate, and entered the company's employ knowing that they had tuberculosis. They continued to conceal their disease as long as they could. Two of these three are dead; one is working.

Ten patients with chronic tuberculosis of the fibrocavernous type appear to have paid little attention to their symptoms, which were annoying but not disabling. They neglected to place themselves under continued medical observation, though most of them had gone to the doctor from time to time and asked for some medicine for a "bad cold," or for "stomach trouble," these being their words for what ailed them.

Four patients had an abrupt and stormy onset, preceded by few symptoms, or none that they noticed. In these cases the disease must have progressed almost silently to the far-advanced stage, when it suddenly produced disability. Hemorrhage was the first frank manifestation in three of the four. They were, of course, diagnosed at once.

So far as these seventeen patients are concerned, there was no diagnostic failure. It would have been better for them if they had been required to pass a physical examination before employment; a periodic health examination would have been even more useful. A warning against tuberculosis, with some mention of the early symptoms,

might well have been included in the safety first articles which were brought to their attention. In nearly half the cases, therefore, the immediate responsibility for delayed diagnosis rests on the patients themselves and the best preventive measure would have been their elementary education in the care of their health.

Seven patients, who had previously been treated for tuberculosis by physicians in the company's employ, relapsed after working for a period of time which varied from six months to as many years, and they were far advanced at the time of their relapse. It does not appear that these workers took the trouble to report regularly for chest examination, nor was any systematic effort made to keep them under observation. It would have been profitable to all concerned if they had been called in for an overhauling, say every three months for the first year and yearly thereafter.

Three men, under treatment for unrelated surgical conditions, developed tuberculosis of the lungs while under medical observation and it was not detected early.

Eleven men had been ailing, off and on, for months or years. If their statements are true, they had repeatedly gone to their local surgeons complaining of frequent colds, chronic coughs, persistent indigestion, loss of weight, lack of endurance—symptoms which should cause a medical man to remember the existence in the world of a disease called tuberculosis. But their sputum was not examined, their chests were not X-rayed; they were given medicine to take; and they were far advanced when the diagnosis was finally made. It may be merely a coincidence that several of this group had been under the care of one surgeon.

In fairness, it should be said that many railroad men, if not completely disabled, will not take time off to consult their doctor at regular hours; they hurry in at the end of the day, or the end of the run, asking for medicine for this or that symptom, take the prescription, and disappear. And it is pertinent to remark that, while a few of the company surgeons are on a salary, most of them receive for their work no tangible compensation other than an annual pass.

It is apparent that free medical service, without special attention to the prevention and detection of tuberculosis, has not availed to control the menace of tuberculosis to this particular industrial group. The purpose of this study is not to fix the blame for this failure but to find the reasons for it, and, if possible, the remedy. It is hoped that the work, though limited in its scope, will be of some use to others interested in industrial medicine.

The underlying cause of the delay in diagnosing tuberculosis seems to have been the human tendency to overlook the obvious, to ignore commonplace knowledge, and to look for the new. The employees must have encountered consumptives frequently; the train crews of necessity saw them, both alive and dead. The company doctors knew that tuberculosis is still a prevalent disease, fifth among the causes of death and ranking higher than that as a cause of disability and poverty. That they were not shirking work is shown by the operations they did for the elimination of foci of infection, to

which they not infrequently attributed the symptoms caused by early tuberculosis. While the total damage from tuberculosis was considerable, the incidence of the disease in the separate groups was not heavy enough to hold the attention of either physicians or laymen.

Admittedly, not all cases of tuberculosis can be detected early, unless recourse is had to entrance examinations and periodic health examinations conducted by experts. But it should be possible to bring about a much earlier diagnosis of most cases, without changing or overtaxing the existing organization. People nowadays are accustomed to have their thinking done for them; they are ruled by advertising. The thing to do in this instance is to advertise tuberculosis. It might be difficult to educate the rank and file of the employees to be alert for the well-known onset symptoms of tuberculosis, but it would be easy to instruct their leaders, the bosses and foremen and superintendents, as one of the ordinary safety first procedures, to send in for examination all workers, whether in field or office, who suffer from persistent cough, failure of efficiency, or obvious loss of weight. The situation should be brought frankly to the attention of the company doctors. While it is not to be expected that a busy surgeon should infallibly search for and detect the physical signs of early tuberculosis, he may reasonably be required to have the sputum of every suspected employee examined, not once but repeatedly if cough persists. Roentgenograms of the chest, made and interpreted by X-ray workers experienced in chest work, should be used as a matter of routine. The cost of the treatment of one hopeless case would pay for many such films. And, in order to insure the co-operation of the patients, the trip to the hospital for diagnostic work had better be made on the company's time. Finally, the recovered patient when returned to work should be brought in for periodic examinations until the danger of relapse, greatest in the first year and decreasing thereafter, becomes remote. A man worth repairing is certainly worth keeping in repair.

So much for the white employees. The situation in respect of the laborers, particularly the Mexicans, is less hopeful. Our histories of these are as a rule not satisfactory; many are illiterate, and we cannot trace them after discharge. Often they do not cooperate well in their treatment; they have a racial lack of immunity to tuberculosis; they insist on living as they did in their own country. Nearly all are far advanced when diagnosed, and recovery is the exception. Eleven of the twenty-eight died in the institution where they were treated. There appears to be nothing to do with them under the present system except to give humanitarian care to the ones that fall sick, and to trust to their enlightenment through the education of their children. If more is to be accomplished, routine physical examination will have to be made a condition of their employment.

But the whites, who outnumber the foreigners, are educable; and the simple measures outlined above, if put into effect among them or in any other industrial group, should be well worth while. For tuberculosis is not prone to attack the sluggard and

the shirk; it selects its victims from the energetic workers, those who keep going to the limit of their strength. And such persons, if put under treatment early, are likely to be returned without serious damage.

Summary

This article is a review of the cases of tuberculosis occurring in a group of railroad employees during four years. The annual tuberculosis admission rate in this group was about one case to every 800 employees.

These employees lived in a good climate; they earned adequate wages; they were members of a hospital association and as such were entitled to free medical service, and to free sanatorium treatment.

The detailed study is limited to the white employees, mostly skilled workmen or office workers of whom full histories and nearly complete follow-up records are available: There were forty-four such patients, of whom thirty-eight were classified as far advanced when admitted to the sanatorium, fifteen of these being rated as far-advanced "C."

The mortality from tuberculosis among the far advanced, within four years of their admission, was nearly 40 per cent. Only seven of the far advanced have gone back to their former jobs.

All the moderately advanced and minimal patients recovered, and are able to work.

It cost the hospital association on the average $4,600 to put a far-advanced patient in condition to resume his former job; the cost for the moderately advanced was about $1,050; and for the minimal, about $450.

Inquiry concerning the reason for delay in diagnosis shows that three patients deliberately concealed their symptoms; ten neglected to consult the company doctor until late in their disease; and four, whose disease had progressed silently, were far advanced at the time of the abrupt onset of symptoms.

Seven were old cases, formerly treated. They had not been under regular observation since their return to work.

Eleven, who had been more or less under medical observation for symptoms suggesting the existence of tuberculosis, were not diagnosed until late. Tuberculosis appeared as a complication in three surgical cases, and gained considerable headway before it was detected.

Free medical service, without special attention to the prevention and detection of tuberculosis, did not control consumption in this industrial group.

The underlying cause of the delay in diagnosis appears to have been the tendency, on the part of laymen and doctors alike, to ignore the commonplace knowledge of the prevalence of tuberculosis, and of its earlier symptoms. They were not "tuberculosis-minded."

It is desirable to bring to the attention of both laymen and doctors, with sufficient frequency and emphasis to make the impression persist, the prevalence of tuberculosis among industrial workers, and the early symptoms of that disease. In a world full of advertising it is necessary to advertise tuberculosis also.

Repeated examinations of the sputum, and roentgenograms of the chest made by X-ray workers skilled in chest work, should become the routine and not the exceptional method in dealing with suspects. Reliance should not be placed on a casual physical examination. Tuberculous patients returned to work should be kept under observation until the danger of relapse becomes remote.

In groups covered by any sort of health insurance, and under even limited control, these measures are practicable and they will more than repay their cost.

NERVOUS ILLNESS IN INDUSTRY*

MILLAIS CULPIN, M.D., F.R.C.S.

ONE of the few benefits that arose from the Great War was the attention drawn toward disabilities known by such names as nervous breakdown, nervous exhaustion, traumatic neurasthenia, or hysteria. These, occurring *en masse* in the armies of all belligerent nations, were given by us the misleading name of shell shock and were at first regarded as a new disorder arising from the physical effect of high explosives, though ultimately it became clear that, except in the form of some of the symptoms, they differed in no way from similar disorders in civil life. A general name for the group is "functional nervous disorder," a term paradoxically signifying that we know nothing about the state of the nerves supposed to be concerned in them. Their symptoms are disturbances of impulse, feeling, emotion, or behavior, though the altered emotional state may show itself by physical symptoms such as palpitation or digestive troubles; indeed, more physical disturbances than we suspect are probably determined by emotional states. From one point of view these disorders are failures to adapt oneself to the demands of life, whether those demands arise from modern warfare, from industrial or social life, or from more personal conditions.

* Received for publication Aug. 20, 1928.

Study of the war cases showed that in from 42 per cent.[1] to 72 per cent.[2] a predisposition to break down was demonstrated by the existence of symptoms before enlistment. But here arose a fallacy, for we had no means of knowing how many men in the army had such symptoms and did not break down, or how many of the general population possessed such predisposition.

The opportunity to examine this latter question was given when an investigation was made into telegraphists' cramp by Mr. Eric Farmer, Miss May Smith, and myself, under the direction of the Industrial Fatigue Research Board.[3] The investigators finally regarded the condition as belonging to the group of so-called nervous disorders, and in forty-one subjects found that twenty-six (63.4 per cent.) had symptoms, quite apart from the cramp, which would of themselves justify the diagnosis of a severe nervous disability.[4] Of a control

[1] Culpin, M.: Psychoneuroses of War and Peace. Cambridge, University Press, 1920, p. 40.

[2] Mott, F.: War Neuroses and Shell Shock. Oxford Med. Publications, 1919, p. 110.

[3] Culpin, M., Farmer, E., and Smith, M.: A Study of Telegraphists' Cramp. Indust. Fatigue Res. Board, Rep. No. 43. London, H. M. Stationery Office, 1927.

[4] I am compelled by the force of custom to use the word "nervous" and its congeners to indicate the disorders under discussion. Most of the symptoms can be usefully described only as alterations of emotion, im-

group of forty-six supposedly healthy telegraphists, 65 per cent. passed my scrutiny as free of symptoms, 28.5 per cent. showed symptoms in a mild degree, and 6.5 per cent. had severe symptoms. An examination of fifty boy and fifty girl learners gave the following results:

Symptoms	*Girls* %	*Boys* %
Absent	66	46
Mild	28	48
Severe	6	6

As an example of severe symptoms—important, too, because of their likely influence on telegraphy—some of the information supplied by a boy of 19 may be given:

> I don't get on any too well at the work. I'm under the impression something is wrong, and it makes it go wrong. I have trouble with the letter V and the figure 4; I want to rush them. I am worse when watched. I often have a feeling that people are watching me, though I have hardened myself to it. I don't like to buy my clothes; I get my brother to do it. When I have done something I am never sure that I have really done it. I am always imagining what would happen in an accident. I have few friends and am always trying to convince myself of my own opinions.

It may be objected that each symptom by itself is trivial, but, taken together, the symptoms are sufficient to make it doubtful whether this boy will ever become an efficient telegraphist, and, in the experience of medical men who are accustomed to look for such symptoms, they are the basis upon which are built nervous breakdowns, shell shock, traumatic neurasthenia, and the like, as well as some ailments that appear as physically determined diseases. That an inhibition about buying clothes could signify a liability to telegraphists' cramp is, one must admit, a novel idea. Its significance lies in the fact that such a susceptibility to the influence of his fellows will make the subject apprehensive of possible criticism from the operator at the other end of the wire and induce a state of mind that may express itself in cramp. A parallel is found in those sufferers from stammering or writers' cramp who can read aloud or write easily when not under observation; the presence of possible critics determines the appearance of the symptom, whatever additional factors may be at work.

Miss May Smith and the writer have since investigated over a thousand workers and students by a joint method which consists of an interview in which character traits and nervous symptoms are sought out, together with a test of performance on the McDougall-Schuster dotting machine. This test, originally devised as a measure of muscular accuracy and voluntary attention, is the survivor of several that we tried as checks upon the result of the interview, for that must always be influenced by the personal equation of the investigator. Without going into figures, I will state that there is sufficient agreement between the two groups of results to indicate that the interviewer measures

pulse, or behavior and they should properly be called mental, though unfortunately the word "mental" is wrongly taken by the public to mean "insane." A nervous breakdown is generally a mental disturbance; we know nothing whatever about any physical change in nerve tissue connected with the breakdown; but the word "nervous" has to be used in deference to widespread misunderstanding.

something that is also measured by the dotting machine and that his results are therefore not entirely imaginative. The agreement, however, is not great enough for one method to be substituted for the other.

Such an investigation depends on the good will of the subjects, and accordingly it is always made clear that the subject is invited to assist voluntarily in a scientific research. In a few cases, less than 1 per cent. of the whole, I have suspected that the subject was on guard against revealing symptoms, and that suspicion has invariably been confirmed by his poor performance at the dotting. There is, too, the patient in whom anomalous physical symptoms of an hysterical type are accompanied by an overemphatic denial of nervousness, the denial being typical of his condition. On the whole, however, the subjects have given every assistance; though I am still capable of being surprised at the frankness with which distressing symptoms, hitherto concealed from everyone, have been revealed to a stranger whose only claim is scientific interest, aided by the knowledge that symptoms are often more painful because they are apparently ridiculous. A formal questionnaire is useless, but certain conversational gambits have evolved in the course of the investigation. "How do you like the work?" was such a gambit; a record of the answers shows that a high percentage of favorable replies in an establishment is correlated with a comparatively low sickness rate. The question "Do you call yourself a nervous person?" generally calls forth an honest answer, of which the manner is as important as the words. Specific inquiries as to traffic fears, fear of the dark, or a feeling of being looked at may give the clue to other symptoms. In our later work I have asked about the reaction of the subject to noise, since noise is claimed to have an influence in causing nervous breakdown. We have already found that a subject who cannot work in a room where a typewriter is clicking, or one who is annoyed by outside noises, is sure to reveal nervous symptoms in other directions. The subject marked "naught" can reconcile himself to most noises after a day's exposure.

As an example of a severe nervous condition I will give a story obtained in a twenty-minute interview with a female laundry worker, aged 34, married, and having four children:

> I like the work very much and wouldn't change it. My nerves are bad; the least worry makes me go all of a shake; the doctor said it was my teeth. I am afraid of the dark or of being alone; and wouldn't go along a dark road. I can't bear to be alone in a room; and should worry and fidget in this room (claustrophobia). I never go in a bus; wouldn't go alone in a train. I have a feeling of being looked at; I never go out by myself. (Says she always waits for some one to walk home with her from work and arranges for an escort to work.) I should worry if the boss sent for me; it makes you go all hot. We've all been born with nervous debility. My husband is bad-tempered. I cannot go to the pictures; cannot mix with people.

Her dotting was very bad, but she looked an ordinary, rather stout, working woman and her employers had no suspicion of her nervous state; her work was satisfactory and she had no notable loss of time from sickness. In other walks of life this woman would certainly have suffered from severe

"nervous breakdown." In this particular trade highly nervous people are able to do satisfactory work, and perhaps this is related to the fact that a high percentage—over 90—of the workers like the work and cannot be induced to express a wish to change it. In the interview such a frame of mind is further tested by the question "If you were leaving school and going to work afresh, would you choose this sort of job?"

Let us compare this case with that of a female clerical worker, aged 33, single:

I don't like the work; it's so monotonous. A month ago I was away because of nerves. I had made an error and it worried me so. I am always afraid of the dark and of being alone. I have a slight feeling of being looked at. I am nervous if spoken to by strangers. Pictures try my eyes. I have bad days, with no energy and a feeling of something awful going to happen—like a cloud. Tennis is too much for me. Influenza left my heart weak; it makes me go faint in trains and crowds. I couldn't sit in a small room like this; it makes me come over all faint. No, not frightened at all; it's the heart. (Note that the claustrophobia is here disguised as a heart symptom. She wears glasses (very weak ones) for eyestrain and headache—a typically nervous reaction. She had all her teeth out for gastritis before the age of 21 (probably another nervous symptom). She does not look forward to staying on at her present work. Her dotting score was bad.)

These two cases are very similar, but in the second case the nervousness tends to masquerade as physical disease—disease, however, of a kind quite characteristic of the nervous subject.

The next example, in a man, aged 37, shows the process of camouflage carried a little further. The reader must understand, however, that the term camouflage does not imply conscious deception on the part of the patient; it belongs to the mental state peculiar to the type of disorder:

I'm not nervous, but rather brazen; I'm very confident. (He expresses contempt for those who are afraid of the boss; and never worries about the work. He tells of bilious attacks in which he cannot see, when he has pins and needles in his fingers and is relieved by calomel in half an hour, but has a headache following. He also admits that he would not sit in the front six or seven rows in the gallery at a picture show.)

The brevity of the story is due to the fact that the case came early in the investigation, when the technic of obtaining information had not been developed. But the "bilious attacks" are like nothing known to medicine; and the swift relief by calomel is a mental rather than a physical manifestation. The gallery difficulty indicates a phobia of some kind; and one is not surprised to find that the man suffers from an occupational neurosis.

There are no absolute standards of physical health, and so little attention has been given to the nervous health of individuals that the writer approached with reluctance and vacillation the task of formulating standards in this investigation. After trial of other classifications, subjects who revealed no symptoms and gave no impression of nervousness were placed in the "naught" group; those with an isolated symptom were given one mark; and with increasing number and severity of symptoms the marks were increased till five represented a condition judged to be urgently in need of treatment on account of interference

with happiness or efficiency. Note that the word "normal" is avoided, inasmuch as it is a mathematical expression, not synonymous with "healthy;" it is possible that most of my "one" group would be considered healthy by themselves and others.

Let us now accept the proposition that people who receive a high assessment—3 or over—are those who make heavy weather of life and are likely to become victims of nervous breakdowns, or, what the writer believes to be their equivalent, occupational neuroses like miners' nystagmus or telegraphists' or writers' cramp. Table 1 shows the percentage distribution of the assessments in different groups investigated.

Group A represents establishment F. C., whose sickness record is detailed later in this paper. This record showed an absence of nervous illness, and this is associated with a high percentage of the first two assessments and an absence of any assessments in the last two groups. But this is not the whole of the information available, for we know that special circumstances directed the attention of the medical staff to the importance of studying the temperamental qualities of their employees, and there had been a definite attempt to exclude people judged temperamentally unfit. The results seem to have been the exclusion of hysterics, and of some anxiety subjects, but probably a selection of a peculiar type known technically as obsessionals, who are by no means to be rejected on grounds of inefficiency. The firm has a high percentage of employees (84 per cent.) who say they are satisfied with their job.

Group B has not been subject to this selection, and only 62 per cent. are satisfied. Their sickness rates, however, show no excess of nervous troubles.

TABLE 1.—PERCENTAGE DISTRIBUTION OF ASSESSMENTS IN DIFFERENT GROUPS

MARK	CLERICAL WORK		ROUTINE CLERICAL WORK		LAUNDRY	ART SCHOOL	TELEGRAPH LEARNERS
	A	B	C	D	E	F	G
0	60	46.4	52	49	43	32.0	54
+1	19	22.0	20	21	25	26.8	27
+2	18	20.0	11	17	12	16.0	13
+3	3	9.3	10	8	15	14.4	5
+4	0	2.0	6	3	5	9.0	0
+5	0	0.0	1	2	0	1.8	1

Groups C and D are very similar. There is a considerable amount of nervous illness, and only 58.4 and 64.3 per cent. are satisfied with their jobs.

Group E produced results that surprised us. We knew that nervous illness was nonexistent therein, and we expected to find a totally different incidence of latent troubles. Yet our findings gave results practically identical with those obtained from clerical workers. (The first two assessments should be added together to give a fair comparison; a change in the standard of assessment has increased the +1 class at the expense of the "naughts.") Contentment with the work seems to be a characteristic of this laundry—which is managed on enlightened lines—and it was rare to find a worker who could be persuaded to express a wish to change into any other occupation. Later experience, however, suggests that laundry workers generally would give similar results both with regard

to assessments and with regard to absence of nervous illness.

Group F gave us an insight into what is described as the artistic temperament. All its members were in fairly comfortable financial circumstances, and all were in an occupation which they had selected in accordance with their own desires. No illness records were kept, but absence was negligible. The high assessments were largely due to the presence of obsessional subjects.

Group G suggests that symptoms are absent or less easily detected in some young people who will probably show symptoms at a later period. It shows, however, that symptoms are present at an early age and can be detected.

Among the laundry workers are a fair number of girls between 14 and 15 years of age. Although symptoms in these are not well defined, yet types can be recognized and the assessments are confirmed by the dotting test.

Early in our work we found that there was no significant statistical difference between the results in the two sexes, and therefore no attempt has been made to keep the figures separate.

Except for Groups A and F there seems to have been no selective process at work that should affect our findings; and, with these two exceptions, the percentages of the assessments roughly correspond. We may assume that we are approaching an estimate of the number of the general population who are specially liable to nervous troubles. Laundry workers (Group E) and clerical workers (Groups B, C, and D) show no outstanding difference. But now our previous proposition seems to be contradicted, for there is hardly any nervous illness among laundry workers, while the workers in Groups C and D show a high amount of such illness.

If we suppose that a high assessment of an individual means liability to, or the existence of, nervous illness, we must now admit that other factors are necessary to the production of such illness as will show itself in sick leave. Group A, whose medical staff have paid attention to the possibilities of nervous illness, seems to escape it entirely, though two cases of leave after influenza may possibly indicate what is often described as "nervous debility after influenza"—a condition which, in my experience, is accompanied by evidence of nervous predisposition. I make this suggestion because the medical records of this firm are so extraordinary in their freedom from nervous illness that one is impelled to seek for some flaw in them. Their record for all long illnesses in one year is given in Table 2.

Table 3 shows a remarkable contrast. It is taken from the records of a larger establishment and only the first twelve cases are given. The reader should have no difficulty in recognizing the predominance of nervous illness; I can give my assurance that any sequence of twelve cases would show the same general picture.

This remarkable difference is partly accounted for by the special alertness of the medical staff of Group A, but a personal impression gained by interviewing a random sample of all grades of the staff is that the establishment is progressive and successful, that there is an excellent combination of discipline and initiative so that every member pulls his weight, and that

grievances are few. There is reasonable security of tenure and, as the sickness records show, long sick leave is given without involving dismissal.

But the lowest recorded sickness rates we know are in an establishment where there is little security of tenure, where work is hard and hours are long. The highest are in an industrial establishment where everything that can be suggested for the physical welfare of the workers is carried out, and where tenure is as secure as it can be made when manual workers are concerned. Here, however, scrutiny of the diagnoses reveals a large amount of illness that is probably nervous in origin.

The advantages of security of tenure to the nervous subject would appear at first sight to be great. But I have said that his illness is to be regarded as a failure to adapt himself to the demands of life, and with security of tenure goes a rigidity of environment that often makes peculiar demands in the way of personal adaptation. As a pure speculation I suggest that the absence of nervous illness among laundry workers is partly due to the fact that the laundry trade is prosperous; hence the possibility of being dismissed at a week's notice is compensated for by the possibility at any time of finding other work easily, if personal difficulties arise.

There are, however, more subtle factors at work. The woman worker of 34 whose case is described above had been in a parlous state for years, although she offers by no means an isolated example of the difference between nervous *symptoms* and nervous *disability*. There are certainly few occupations in which such a sufferer could carry on her work happily and without interruption from illness.

TABLE 2.—RECORD OF LONG ILLNESSES DURING ONE YEAR, GROUP A

DAYS LOST	DIAGNOSIS
48	Cold abscess of thigh.
48	Duodenal ulcer: operation.
33	Appendicitis: operation.
126	Injured in motor accident.
42	Influenza.
30	Influenza.
72	Appendicitis: operation.
38	Motor accident.
90	Pulmonary tuberculosis.
108	Pulmonary tuberculosis.
98	Renal calculus: operation.
222	Sarcoma of ilium.

Average days of sick leave per head per annum: 3.6.

TABLE 3.—TWELVE CASES FROM ILLNESS RECORD OF LARGER ESTABLISHMENT THAN GROUP A

DAYS LOST	DIAGNOSIS
156	Influenza and pleurisy.
159	(In separate periods): Influenza, influenzal debility, nervous debility, nervous exhaustion, influenza.
124	Nervous debility.
181	Cough, high blood pressure, bronchial catarrh, and fibrositis.
278	Dyspepsia and nervous debility.
109	Cardiac and nervous overstrain.
92	(In two periods): Debility after appendicitis, influenza, lumbago.
140	Rhinitis.
243	(In two periods): Pyrexia, hydronephrosis.
105	General debility.
94	Debility.
123	Nervous breakdown.

Average days of sick leave per head per annum: 7.7 for men; 14.1 for women.

I fear that at this stage the reader is beginning to think that our investigations are revealing a number of unsuspected problems and offering but little to their solution. That may be so, but the realization of the nature of a problem is the first step to its solution. I throw out the suggestion that the well-known liability of specific individuals to repeated accidents will find an explanation in the presence of unsuspected nervous symptoms which it is not yet customary to seek in such people. I once published[5] an autobiography of a shell shocked soldier in which he gave an account of a railway accident that he caused when employed as a signalman, with a frank description of his mental state before and after the accident. Although the point of view was not in my mind when I published the story, yet it stands as a striking example of a mental state causing an accident and yet escaping notice at a subsequent inquiry.

A further problem forming part of this subject is miners' nystagmus. This disease, now costing us about £600,000 per annum in compensation, is characterized by oscillations of the eyeballs (nystagmus); but there are, according to some authorities, as many as 35 per cent. of miners in safety lamp mines who show this sign and make no complaint of any disability. The disabling symptoms are nervous, and are identical with those known and described in soldiers suffering from shell shock. The symptoms—except some connected with the eyes, but also occurring in shell shock— are met with in miners who do not show the oscillation of the eyeballs but these men are not reckoned to be suffering from the compensated disease since they do not fall into the 35 per cent. who show oscillation. In my opinion, which is not generally accepted, we have, without recognizing its nature, been paying compensation for a disease which belongs to the disorders I have been discussing in this paper. The enormous increase of compensation is inevitable in such circumstances. The situation is the same as if shell shock were regarded as a physically determined condition, just like a wound. This actually happened at first, but recognition of the true nature of the disorder was forced upon the authorities and the use of the phrase shell shock was officially prohibited.

This leads us to the most difficult problem of all, a problem so great that we are almost compelled to shut our eyes to it. The moral opprobrium implicit in such words as "neurotic" or "hysterical," and avoided by the use of "nervous breakdown" or "neurasthenia," indicates a belief that the symptoms have an element of make-believe about them and are within the control of the patient. Yet no one can read the accounts of the cases given above without realizing that the symptoms are real and distressing to the patient. I have already made a distinction between nervous *symptoms* and nervous *disability*, and it is in this distinction that our difficulty lies. The nervous subject may carry on his work under great difficulty, but even so he may be happier and healthier than when he gives in. If we make it easy for him to give in, he will often do so, for he carries on only at a price. If every man with shell shock had been

[5] Culpin, M.: Psychoneuroses of War and Peace. Cambridge, University Press, 1920, p. 103.

shot, the number of shell shocked would have been far less than it was when the condition often meant an honorable escape from the inhuman conditions of warfare; but an appalling number would have had to be shot. If every shell shock patient, after efficient treatment, had known that he would get no pension, some who are now hopeless wrecks would have made enough effort to reach some degree of cure; but serious injustice would have been done to a greater number. The Continental method of handling miners' nystagmus is less lenient than ours and, I have no doubt, actually keeps down the amount of disability and suffering—for the nervous patient whose disability is kept alive by compensation is not a happy man—but probably at the expense of some hardship.

We are faced with a dilemma as the obligation to care for the sick is more and more recognized. The nervous subject finds adaptation to the demands of life difficult. His difficulty shows itself, and at the same time finds a false solution, in illness—to be emphatically distinguished from malingering and freed from the moral judgment involved in the word "neurotic" —that demands recognition and treatment, but can be perpetuated in the individual and encouraged in the mass by weakening the stimulus to recovery. Meanwhile an obvious step toward solution of the dilemma seems to be the investigation of the conditions under which adaptation becomes difficult to the numerous susceptible persons among the general population.

Investigation has already shown that it is possible to detect these susceptible ones. They are not of necessity incompetent or untrustworthy. In fact, one particular type of nervous person stands out above the average in intellectual alertness and ability, thus supporting the claim that most original work is carried out by nervous people; closely related to this type is the overconscientious man who, making heavy weather of life by his inability to let things slide, reaches nervous breakdown apparently through overwork, when in reality the overwork was a manifestation of the temperament that made breakdown inevitable in the absence of a helping hand guided by a knowledge of his type. Overwork can tire a man and make rest and recreation an absolute need, but when such needs are satisfied recovery takes place unless other and deeper influences are present. That nervous breakdown never results from overwork alone is an opinion in which I am becoming more and more confirmed.

The striking difference between the incidence of nervous illness in different occupations offers practical help in occupational guidance. I should, for example, advise the nervous youth of either sex to avoid telegraphy, for there seems something inherent in telegraphy that invites nervous tendencies to become manifest as cramp. That security of tenure should be sacrificed in favor of a potential mobility inside the chosen occupation is more venturesome advice to the nervous, but there is a great deal in its favor. We ought to be able to differentiate various temperamental types just as we already differentiate intellectual types, and to apply that knowledge in selecting or directing aspirants to particular occupations.

The question why so many people

suffer from nervous conditions or predispositions is too difficult to discuss here; even their treatment is a matter on which the widest diversity of opinion exists. But they create problems in industry that are only now being recognized. If persons in authority, welfare workers, and any others concerned, feel stimulated to learn more about such conditions, I can assure them that there is all around them ample material from which to learn. No harm can be done by allowing the nervous person to relate his symptoms to some one who will not dismiss them as "neurotic;" the mere listening to them places the listener in a position to advise and encourage, and if he listens enough he may gain knowledge concerning nervous illness in industry that will be worth adding to our meager store.

LEAD ABSORPTION AND COMPENSATION*

MAY R. MAYERS, M.A., M.D.

Bureau of Industrial Hygiene, New York State Department of Labor

COMPENSATION for industrial diseases as distinguished from compensation for accidents is of comparatively recent origin. Its introduction has opened to the compensation tribunals a field of obviously vast importance and vast extent; a field, however, which is also of vast difficulty and complexity. To determine the extent of a disability and its true cause is, frequently enough, a matter of real difficulty even in cases where the disability is claimed to have resulted from an accident; immeasurably more difficult is it likely to be where the alleged and possible cause is a disease, possibly devoid of acute clinical symptoms: a disease of nonbacterial origin; with no pathognomonic sign or symptom; and the very existence of which it may be difficult to predicate with confidence.

While it is clear that the long-continued maintenance of abnormal biochemical and physiologic relations in the body, such as result from prolonged exposure to the industrial poisons, must needs be harmful in a cumulative way, actual disease entities may appear only after gross injury has been done, and it is frequently very difficult to determine with any degree of certainty what is the true etiology. An environment not sufficiently injurious to produce a definite pathologic lesion at the immediate site of injury, but which, nevertheless, for a long time unduly taxes or disturbs any or all of the normal regulating functions of the body, will eventually cause a break somewhere in the human machine. And this break is frequently at some point where the person is congenitally weak, or at some point where the local resistance has been lowered, as by trauma, for example, rather than where it would be naturally looked for on the basis of his occupation.

Among the limited number of industrial diseases which the legislature of the state of New York has thus far seen fit to regard as compensable under the Workmen's Compensation Law, lead poisoning is easily the most important. The proper solution of the problems arising from claims of disability or death alleged to have been caused by lead poisoning is thus of importance not only from the standpoint of the number of cases involved, but also because such a proper solution must have a large influence on the proper development of the law and on procedure of compensation for occupational diseases generally.

The diagnosis of lead poisoning in all but its acute or advanced stages has always been beset with difficulties, both because of the indefiniteness of

* Received for publication Nov. 5, 1928.

many of the symptom-complexes and because medical authorities have differed in their interpretation of some of the terms used. There are those, for example, who consider that no case should be properly diagnosed as lead poisoning in the absence of lead colic. At the other extreme, there are those who take the position that the presence of stippled cells in the blood is, in itself, sufficient for the diagnosis. Innumerable intermediate positions have been taken by as many different medical men. When these differences of opinion are examined, however, one is impressed with the fact that they are usually due to differences of opinion as to the definition of the term "poisoning" rather than to any fundamental differences in the medical interpretation of cases. It was suggested in a previous article (6), therefore, in the interest of the standardization both of terminology and of diagnosis that the more comprehensive term "lead absorption" be applied to all cases in which there is positive evidence that lead absorption is taking place or has taken place, quite regardless of the symptom-complex. Cases presenting acute toxic episodes could then be regarded merely as special cases of lead absorption to which the term "lead poisoning" might properly apply. All this is reviewed here, because it is felt that this terminology would apply equally well not merely to lead but to any of the other industrial poisons which, pharmacologically speaking, resemble lead in their cumulative effect on the tissues and organs of the body. With standardization of terminology, standardization of diagnosis would be inevitably furthered; and such standardization is regarded as fundamental to justice in the administration of the Compensation Law.

In connection with the present study, several questions, pertinent in their compensation aspects, suggested themselves:

1. Does the absorption of relatively small amounts of lead necessarily or always give rise to a suggestive clinical picture?
2. If so, how frequently does this occur, and is the symptom-complex sufficiently definite to afford a safe basis for a diagnosis?
3. May a clinical picture suggestive of lead absorption or even of lead poisoning be present in the actual absence of lead absorption? This is of extreme importance for purposes of differential diagnosis between an ordinary stomach ache—or, indeed, acute appendicitis—and lead colic.
4. If such a situation does arise, how is it to be interpreted for purposes of diagnosis, and subsequently for purposes of compensation?
5. Can active lead absorption be taking place in the total absence of all clinical manifestations?
6. Statistically, how often are these various situations apt to arise?
7. Is there any relation between the type of lead handled and the tendency to absorption?
8. Does the amount of lead which gets into the worker's nose bear any constant relation to absorption?
9. Is there any apparent relationship between lead absorption and the age of the worker exposed or the duration of his exposure?

It was felt that any light which could be thrown upon these questions would be of more than theoretical value, and the study was conducted with this in mind. Physical examinations were made of 381 lead workers (all men) from twenty-three plants in fifteen of the leading lead industries in the state of New York. The ex-

aminations included, in every case, a careful history, and were supplemented by examinations of both blood and urine. The blood was examined in the laboratory not merely for its red cell count and the presence of stippling, but for all other evidences of a lead anemia. Hemoglobin determinations were made in the plants, by the Sahli method, at the time of the physical examinations. Analyses of the urine and of swabs from the nose were made in the laboratory by the Fairhall method.

Since all the men were examined while at work, there were no cases of acute intoxication and therefore no cases of lead poisoning, in the narrow sense in which the term is being arbitrarily used for the present purpose. The cases which are recorded as showing lead absorption are those in which there was definite laboratory evidence that lead was being actively absorbed (active cases), as well as those in which the presence of the lead line demonstrated that lead had been absorbed at some previous time (inactive cases). This was done quite regardless of whether or not these cases gave clinical manifestations of the disease. While there were cases in which the clinical picture was distinctly suggestive of active lead absorption, in no case was it regarded as sufficiently definite to warrant a positive diagnosis in the absence of laboratory confirmation. Only those cases, therefore, with positive laboratory findings—*i.e.*, either evidences of a lead anemia, with or without the presence of stippled cells in the blood, or the presence of lead in the urine, or both—were grouped as cases of lead absorption. Since lead in the feces was regarded as indicative merely of the fact that lead had been swallowed and not that it had necessarily been absorbed, determinations of lead in the feces were not considered an aid to diagnosis and were therefore not made.

Gastro-Intestinal Tract

The signs and symptoms referable to the gastro-intestinal tract which were regarded as of special interest from the standpoint of lead absorption were the following:

Gastric discomfort
Constipation
Coated tongue
Loss of appetite
Nausea
Vomiting
Abdominal pain or tenderness

There were no cases either of acute colic or abdominal tenderness or of vomiting. The total number of persons with digestive symptoms was found to be 192, or 50.3 per cent. of the total.

Age Groups.—As will be seen from

TABLE 1.—DIGESTIVE MANIFESTATIONS, BY AGE GROUPS

AGE GROUP *yrs.*	TOTAL IN GROUP	CASES WITH DIGESTIVE MANIFESTATIONS	
		Number	Per Cent.
Under 16	1	0	0.0
16–18	16	11	68.7
19–21	29	14	48.2
22–30	108	46	42.5
31–40	116	52	44.8
41–50	66	43	65.1
51–60	27	14	51.8
Over 60	18	12	66.6
Total	381	192	50.3

Table 1, there appeared to be no relationship between the age of the worker and the incidence of gastro-intestinal disturbances. It will also be observed that the distribution of symptoms in the several age groups was fairly uniform. If one considers the group of workers who were 30 years old or under, it will be observed that 71, or 46.1 per cent., had digestive disturbances. Of the workers over 30 years of age, 121, or 53.3 per cent., had digestive disturbances.

Duration of Exposure to Lead.—There appeared to be no relationship between the duration of exposure to lead and the presence or absence of gastro-intestinal signs or symptoms, as can be seen from Table 2.

Lead Absorption.—The 192 cases having digestive disturbances of any kind were further investigated from the standpoint of lead absorption. Of these, 136 cases, or 70.8 per cent., showed lead absorption; the remaining 56 cases did not. In 123 cases, the gastro-intestinal signs or symptoms were unaccompanied by any other clinical manifestations. Of these 85 showed lead absorption, and 38 did not. In 69 cases there were one or more other elements in the clinical picture accompanying those referable to the digestive tract. Of these 51 had lead absorption, and 18 did not.

It is of interest to note that, in the case of fifty-six of 192 men who complained of gastro-intestinal symptoms, no definite evidences of lead absorption could be found when laboratory analyses were made of the blood and the urine. In the case of eighteen of these men, as will be seen from Table 3, the gastro-intestinal symptoms were associated with others suggestive of lead absorption and yet the laboratory tests were entirely negative.

TABLE 2.—DIGESTIVE MANIFESTATIONS, BY DURATION OF EXPOSURE

DURATION OF EXPOSURE	TOTAL IN GROUP	CASES WITH DIGESTIVE MANIFESTATIONS	
		Number	Per Cent.
Under 2 mos.....	28	16	57.1
2– 6 mos.....	57	31	54.3
7–11 "	21	13	61.9
1– 2 yrs.....	72	33	45.8
3– 5 "	86	34	39.5
6–10 "	36	20	55.5
11–15 "	28	12	42.8
16–20 "	19	10	52.6
21–30 "	25	17	68.0
Over 30 yrs.....	9	6	66.6
Total.....	381	192	50.3

TABLE 3.—GASTRO-INTESTINAL DISTURBANCES AND LEAD ABSORPTION

LEAD ABSORPTION	CASES WITH GASTRO-INTESTINAL DISTURBANCES		
	Total	Unaccompanied by Other Disturbances	Accompanied by Other Disturbances
Positive findings.....	136	85	51
Negative findings.....	56	38	18
Total.....	192	123	69

Nervous System

Here again there were no acute symptoms to be found. There was one case, however, of true lead palsy

of what seemed to be rather long duration. Aside from this, the nervous manifestations were confined to headache, dizziness, and tremor.

Headache is a symptom which might quite as readily have been grouped with the gastro-intestinal symptoms as with those of nervous origin. The cases which on examination, however, appeared to be definitely associated with digestive disturbances were put into that group. The cases here listed seemed rather to be of nervous origin. There were forty-four cases of headache of this type, representing 11.5 per cent. of all the workers examined and 30.7 per cent. of the 143 cases with nervous manifestations.

There were thirty-seven cases of dizziness. These are all cases in which the worker claimed that he had never noticed that he had suffered from dizziness before exposure to lead. The thirty-seven cases of dizziness represent 9.7 per cent. of all the cases examined and 25.8 per cent. of the 143 cases in this group.

There were 102 cases of tremor of the hands or the tongue. It was extremely difficult to arrive at a means for properly evaluating the rôle which lead played in producing the tremor which was found among these workers. In order to eliminate the possibility of tremor due to excess alcoholism, the workers were carefully questioned on this point. In the case of all those who were heavy drinkers, the tremor was attributed to alcohol, rather than to lead. The 102 cases here listed were believed not to be due to alcohol. These represent 26.7 per cent. of all the cases examined and 71.3 per cent. of the total number of cases showing nervous manifestations. The percentage appears to be high.

The group of cases with nervous manifestations suggestive of lead absorption was almost as large as the group showing gastro-intestinal disturbances. In a number of the cases, both sets of symptoms were found to be associated.

Age Groups.—The distribution of cases by age groups is shown in Table 4. There appeared to be practically the same incidence of nervous manifestations in the group of workers over 30 years of age as in those who were 30 years old or younger—37.4 and 37.6 per cent., respectively.

TABLE 4.—NERVOUS MANIFESTATIONS, BY AGE GROUPS

AGE GROUP *yrs.*	TOTAL IN GROUP	CASES WITH NERVOUS MANIFESTATIONS	
		Number	Per Cent.
Under 16	1	0	0.0
16–18	16	6	37.5
19–21	29	13	44.8
22–30	108	39	36.1
31–40	116	33	28.4
41–50	66	29	43.9
51–60	27	13	48.1
Over 60	18	10	55.5
Total	381	143	37.5

Duration of Exposure to Lead.—When these cases were considered from the standpoint of the duration of exposure to lead, the results were as shown in Table 5. Prolonged exposure to lead appeared to have some relation to the prevalence of nervous manifestations in these cases. There were 264 cases in the group

exposed to lead for five years or less. Of these, eighty, or 30.3 per cent., had nervous manifestations. Of the 117 men who had been exposed to lead for more than five years, sixty-three, or 53.8 per cent., had suggestive nervous manifestations.

Lead Absorption.—Ninety-seven cases in this group (67.8 per cent.) showed lead absorption (Table 6). Forty-six cases, or 32.2 per cent., showed no lead absorption. In 111 cases, the nervous signs or symptoms were associated with signs or symptoms referable to other systems of the body, usually with those referable to the digestive tract. In 32 cases, the nervous manifestations were not associated with these other manifestations. Of the 111 cases mentioned, 76 had lead absorption, while 35 apparently did not. Of the group of 32 cases, 21 had lead absorption, while 11 did not.

It will be observed that here, as in the group presenting digestive disturbances, the cases showing lead absorption were just about twice as numerous as those not showing the absorption of lead. Also, in both groups, there were a number of cases in which nervous manifestations occurred both alone and associated with other clinical manifestations suggestive of lead absorption. Nevertheless, in many of these cases, it will be seen that laboratory evidence that lead was actually being absorbed at the time the examinations were made was entirely lacking. It was felt, moreover, that the symptom-complexes presented by these individuals, although clinically suggestive, were insufficiently conclusive for a positive diagnosis of lead absorption in the absence of laboratory confirmation. While the laboratory cannot, of course, be regarded as infallible, the present experience would seem to emphasize again the fact that recourse to the laboratory is the only way in which it can be hoped to obtain any approach to accuracy in the diagnosis of this

TABLE 5.—NERVOUS MANIFESTATIONS, BY DURATION OF EXPOSURE

DURATION OF EXPOSURE	TOTAL IN GROUP	CASES WITH NERVOUS MANIFESTATIONS	
		Number	Per Cent.
Under 2 mos.	28	10	35.7
2– 6 mos.	57	15	26.3
7–11 "	21	7	33.3
1– 2 yrs.	72	17	23.6
3– 5 "	86	31	36.0
6–10 "	36	24	66.6
11–15 "	28	12	42.8
16–20 "	19	7	36.8
21–30 "	25	14	56.0
Over 30 yrs.	9	6	66.6
Total	381	143	37.5

TABLE 6.—DISTURBANCES OF THE NERVOUS SYSTEM AND LEAD ABSORPTION

LEAD ABSORPTION	CASES WITH NERVOUS DISTURBANCES		
	Total	Unaccompanied by Other Disturbances	Accompanied by Other Disturbances
Positive findings	97	21	76
Negative findings	46	11	35
Total	143	32	111

very troublesome disease. For purposes of compensation it would certainly seem that the diagnosis in these *doubtful* cases must be left to the laboratory for final decision.

Skeletal System

Muscle and joint pains were usually spoken of by the workers either as "rheumatism" or "neuritis." In order to eliminate neuritis possibly due to diabetes, the urine was tested for sugar in each case. Those who showed the presence of sugar in the urine were omitted from the series. It was also recognized that workers of this group, because of the high incidence of oral sepsis as well as other foci of infection, would be expected to have considerable susceptibility to rheumatism quite regardless of their exposure to lead. When one considers, however, that lead predisposes to decay of the teeth, it may perhaps, in all fairness, be considered as indirectly responsible for rheumatism resulting from such focal infection. A history of true muscle cramps or muscle spasms could not be elicited in any case.

There were, in all, forty-two cases with muscle or joint symptoms, representing 11 per cent. of the total number of cases examined. Physical examination revealed nothing of interest in this connection.

Age Groups.—Table 7 shows the cases with muscle or joint symptoms, distributed by age groups. An increase in the incidence of muscle and joint pains with increasing age was to be expected, quite regardless of exposure to lead. The high incidence of muscle and joint symptoms, however, in the workers between 16 and 21 years of age is of interest. The precise part played by exposure to lead in the production of these symptoms could not be satisfactorily ascertained, however, as there were too many complicating factors.

TABLE 7.—MUSCLE AND JOINT MANIFESTATIONS, BY AGE GROUPS

AGE GROUP *yrs.*	TOTAL IN GROUP	CASES WITH MUSCLE AND JOINT MANIFESTATIONS	
		Number	Per Cent.
Under 16	1	0	0.0
16–18	16	3	18.7
19–21	29	5	17.2
22–30	108	7	6.4
31–40	116	7	6.0
41–50	66	11	16.6
51–60	27	7	25.9
Over 60	18	2	11.1
Total	381	42	11.0

Duration of Exposure to Lead.—Table 8 shows a distribution of these workers by duration of exposure to lead. It will be seen that there was apparently no relationship between the frequency of occurrence of these symptoms and the duration of exposure to lead, there being almost as high an incidence among those exposed for two years or less as among those exposed for over fifteen years.

Lead Absorption.—When the cases were further analyzed for the presence of lead absorption, it was found that twenty-eight, or 66.7 per cent., of the cases had lead absorption, while fourteen, or 33.3 per cent., apparently did not (Table 9). It is interesting that here, just as in the two preceding groups (*i.e.*, those with digestive

or with nervous manifestations), approximately twice as many of the cases had lead absorption as did not. Here again there were cases of lead absorption in which muscle and joint symptoms appeared both alone and in combination with others referable principally to the gastro-intestinal and nervous systems. There were, on the other hand, cases with what appeared to be almost the same symptom-complex but which nevertheless could not be grouped as cases which were actively absorbing lead at the time that the physical examinations were made, because of the consistently negative laboratory findings.

TABLE 8.—MUSCLE AND JOINT MANIFESTATIONS, BY DURATION OF EXPOSURE

DURATION OF EXPOSURE	TOTAL IN GROUP	CASES WITH MUSCLE AND JOINT MANIFESTATIONS	
		Number	Per Cent.
Under 2 mos.....	28	3	10.7
2- 6 mos.....	57	7	12.2
7-11 "	21	3	14.2
1- 2 yrs.	72	11	15.2
3- 5 "	86	6	6.9
6-10 "	36	1	2.7
11-15 "	28	1	3.5
16-20 "	19	3	15.7
21-30 "	25	5	20.0
Over 30 yrs.....	9	2	22.2
Total.....	381	42	11.0

TABLE 9.—DISTURBANCES OF THE SKELETAL SYSTEM AND LEAD ABSORPTION

LEAD ABSORPTION	CASES WITH MUSCLE AND JOINT SYMPTOMS		
	Total	Unaccompanied by Other Disturbances	Accompanied by Other Disturbances
Positive findings.....	28	3	25
Negative findings.....	14	3	11
Total.....	42	6	36

Clinical Picture and Lead Absorption

It was of interest that in the examination of these 381 lead workers there were 149 cases suspected of lead absorption on physical examination. In the case of thirty-nine of these (26.1 per cent.) when analyses were made of the blood and the urine, and the cases reviewed on the basis of the complete findings, it was considered that the clinical diagnosis was probably incorrect. There were 232 cases, on the other hand, which gave no clinical suggestion whatever of active lead absorption on physical examination, and yet laboratory analysis of blood and urine showed that 112, or almost half of them, were actively absorbing lead at the time that they were examined. Even cases presenting a definite lead line in the gums, it was found, were not necessarily absorbing lead at the time of the physical examination. In no case, as has been stated, was the clinical picture, although ever so suggestive, sufficiently definite to warrant a diagnosis of lead absorption, it was thought, in the absence of laboratory confirmation.

Table 10 summarizes the principal clinical and laboratory findings discussed above.

TABLE 10.—CLINICAL PICTURE AND LEAD ABSORPTION

	NUMBER	PERCENT.
Cases with lead absorption	232	60.8
Active case....222 (58.2 per cent.)		
Inactive cases.... 10 (2.6 per cent.)		
Principal laboratory findings:		
Lead anemia	148	38.8
Lead in urine	116	30.4
Principal clinical findings:		
Pallor	83	21.7
Lead line[1]	31	8.1
Gastric discomfort or pain	46	12.0
Constipation	87	22.8
Coated tongue	149	39.1
Tremor	102	26.7
Headache	44	11.5
Dizziness	31	8.1
Wrist drop	1	0.2
Muscle or joint pains	42	11.0
Hypertension[1]	98	25.7
Arteriosclerosis[1]	86	22.5
Total number examined	381	....

[1] The lead line, arteriosclerosis, and hypertension and their relation to lead absorption were discussed more fully in a previous article in THIS JOURNAL (6).

MATERIALS HANDLED AND LEAD ABSORPTION

It was thought that considerable interest might attach to an attempt to correlate the incidence of lead absorption with particular lead processes and particular materials handled. Table 11 was prepared with this in view.

It was interesting to note that the lead burners who were exposed to lead oxide fumes showed the highest percentage of lead absorption—100 per cent. The solderers, on the other hand, whose work is frequently though incorrectly confused with that of lead burners, showed no signs whatever of lead absorption in the present series. In this connection, it is of interest to recall the fact that Engel and Froboese (3) found that while all flames may cause some volatilization of lead, the largest amount is produced by the use of the blowpipe oxyhydrogen flame when an excess of oxygen is used. This is precisely the type of flame commonly used by lead burners. The smallest amount of volatilization was found to be produced by a quietly burning, slightly luminous flame containing hydrocarbon such as acetylene, oxygen, illuminating gas-oxygen, or oxyhydrogen with the addition of a hydrocarbon.

LEAD IN THE NOSE AND LEAD ABSORPTION

Because of the importance of the respiratory tract as a portal of entry for lead into the body, nasal swabs were taken at the time of the phys-

TABLE 11.—RELATIVE LEAD HAZARD IN THE HANDLING OF VARIOUS LEAD SUBSTANCES

PROCESS OR MATERIALS HANDLED	NUMBER IN GROUP	CASES WITH LEAD ABSORPTION	
		Number	Per Cent.
1. Lead burning (lead fumes)	10	10	100.0
2. Handling metallic lead (cold)	66	49	74.2
3. Handling dry pottery glaze	19	14	73.6
4. Mixing dry chrome colors	11	8	72.7
5. Pottery glaze dipping	14	10	71.4
6. Handling red lead powder	63	41	65.0
7. Handling red lead paste	23	15	65.2
8. Handling wet paint	13	8	61.5
9. Mixing dry ingredients of paint	10	6	60.0
10. Handling molten lead (lead pots)	43	25	58.1
11. Handling white lead powder	26	15	57.6
12. Handling metallic lead (hot)	16	9	56.2
13. Lead smelting	33	18	54.5
14. Spraying paint	9	4	44.4
15. Soldering	25	0	0.0
Total	381	232	60.8

ical examinations and subsequently analyzed for lead by the Fairhall method.[1] The swabs were taken with a clean cotton applicator which was moistened with albolene before using. Great care was taken not to contaminate the swabs with lead dust from the workroom.

Lead was found in the noses of 116 of the workers, or 30.4 per cent. of the total number examined. Of these, ninety-two, or 79.3 per cent., showed evidences of lead absorption while twenty-four, or 20.7 per cent., did not. It would seem from the present experience, at any rate, that the presence of recoverable lead in the nose need not be proof that this lead has necessarily succeeded either in reaching the lungs or in being absorbed into the body through the mucous membranes of the upper respiratory tract.

Very much less lead could be demonstrated in the noses of the workers than was anticipated. Even workers whose faces appeared to be covered with lead dust frequently showed no lead on the swabs taken from their noses. There are two possible explanations for this: (1) The configuration of the nose may be such as to permit the entrance of far less dust from the atmosphere than is commonly supposed; and (2) the lead particles seemed very frequently to become incorporated in the crusted secretions of the nose which it was not always possible to dislodge even with the albolene swab. In this way some of the lead may not have been recovered. In no case was the quantity of lead recovered from the nose swab very large. Indeed, in many instances the quantity was so small

[1] These were analyzed by Dr. F. B. Flinn, at the College of Physicians and Surgeons.

that it was impossible to make any but qualitative determinations.

The various lead processes or materials handled were then studied with a view to seeing whether one or another seemed particularly to predispose to the presence of lead in the nose. The results may be seen in Table 12.

TABLE 12.—RELATIONS OF MATERIALS HANDLED TO RECOVERABLE LEAD IN THE NOSE

PROCESS OR MATERIALS HANDLED	NUMBER IN GROUP	CASES WITH LEAD IN NOSE	
		Number	Per Cent.
1. Mixing dry chrome colors	11	11	100.0
2. Mixing dry ingredients of paint	10	8	80.0
3. Lead smelting	33	15	45.4
4. Handling molten lead (lead pots)	43	18	41.8
5. Lead burning (lead fumes)	10	4	40.0
6. Handling metallic lead (cold)	66	24	36.3
7. Pottery glaze dipping	14	5	35.7
8. Handling white lead powder	26	9	34.6
9. Handling red lead paste	23	7	30.4
10. Handling red lead powder	63	11	17.4
11. Soldering	25	3	12.0
12. Spraying paint	9	1	11.1
13. Handling dry pottery glaze	19	0	0.0
14. Handling wet paint	13	0	0.0
15. Handling metallic lead (hot)	16	0	0.0
Total	381	116	30.4

Age and Lead Absorption

Table 13 shows a correlation between lead absorption and the age of the workers examined.

While on the whole there appeared to be a slight increase in the incidence of lead absorption in the successive age groups, this was not nearly so striking as was the extremely high incidence of lead absorption found in those workers who were between the ages of 16 and 18 years. It will be observed that 87.5 per cent. of the workers in this age group showed evidences of active lead absorption. This would seem to suggest the undesirability of recruiting lead workers from among persons under 18 years of age.

TABLE 13.—LEAD ABSORPTION, BY AGE GROUPS

AGE GROUP *yrs.*	TOTAL IN GROUP	CASES WITH LEAD ABSORPTION	
		Number	Per Cent.
Under 16	1	0	0.0
16–18	16	14	87.5
19–21	29	11	37.9
22–30	108	58	53.7
31–40	116	74	63.7
41–50	66	46	69.6
51–60	27	19	70.3
Over 60	18	10	55.5
Total	381	232	60.8

Duration of Exposure and Lead Absorption

The lead cases, grouped as a whole, were then analyzed with a view to determining whether there was any correlation to be found between duration of exposure to lead and lead absorption. The results are given in Table 14.

It will readily be seen that no definite relationship could be established between lead absorption and exposure to lead on the part of the individual workers. Rather more striking were the differences in personal susceptibility. While some persons apparently showed marked evidences of active lead absorption after a very short exposure, others who had been exposed for over thirty years showed no signs whatever that lead absorption was taking place at the time that they were examined. It will be noted that nineteen of the twenty-eight workers (67.8 per cent.) who were exposed to lead for less than two months showed definite evidences of active lead absorption. Of the nine workers examined who were exposed to lead for two weeks or less, four showed evidences of active lead absorption—one having a typical lead anemia, two having lead in the urine, and one having both of these findings. One extremely healthy looking man, who had been working in the lead oxide room of a storage battery plant for only three days and who had never been exposed to lead before, was found to have lead in his nose, a marked lead anemia with large numbers of stippled cells in his blood, as well as lead in his urine. Clinically he appeared to be so well when he was examined that the laboratory findings came as a complete surprise. On the other hand, every now and again a worker was examined who had been exposed to lead for forty years or even longer and yet on physical examination he appeared to be peculiarly well preserved for his years and to have grown old very gracefully, lead exposure having apparently had no demonstrable effect upon his well-being.

TABLE 14.—LEAD ABSORPTION, BY DURATION OF EXPOSURE

DURATION OF EXPOSURE	TOTAL IN GROUP	CASES WITH LEAD ABSORPTION	
		Number	Per Cent.
Under 2 mos.	28	19	67.8
2– 6 mos.	57	35	61.4
7–11 "	21	10	47.6
1– 2 yrs.	72	38	52.7
3– 5 "	86	55	63.9
6–10 "	36	18	50.0
11–15 "	28	16	57.1
16–20 "	19	14	73.6
21–30 "	25	22	88.0
Over 30 yrs.	9	5	55.5
Total	381	232	60.8

Summary and Conclusions

1. Of the 381 lead workers examined, 232 showed total absence of symptoms or signs suggestive of lead absorption on physical examination. Laboratory tests showed, however, that approximately half of these men were actively absorbing lead at the time they were examined.

2. Of the 381 workers examined, 149 presented a clinical picture definitely suggestive of lead absorption. Laboratory tests confirmed the diag-

nosis in approximately two-thirds of the cases. In the case of the remaining one-third it was considered that the symptom-complexes presented, while suggestive of lead absorption, were probably due to other causes. While none of these workers were incapacitated, cases are constantly arising in which disability is claimed on the basis of clinical symptoms entirely analogous to those found in this group of workers.

Considering the first of these two groups of cases, it would appear that the absorption of relatively small amounts of lead need not necessarily give rise to a typical or indeed even to a suggestive clinical picture. Workers who are apparently healthy on physical examination and who complain of no symptoms whatever may nevertheless be actively absorbing lead. Active lead absorption in these workers presents no problem, however, from the standpoint of compensation for there is obviously no disability present. These cases are of interest primarily to those concerned with proper medical supervision of lead workers, with a view to general prophylaxis and the prevention of acute cases of lead poisoning.

The cases which come to the attention of the compensation tribunals are those in the second group where disability is actual or claimed. The difficulties which arise with reference to these cases may be grouped under two heads: (1) difficulties arising from a lack of standardization of terminology and diagnosis; (2) difficulty in establishing an etiologic relationship between the disability and exposure to lead.

In acute cases of lead poisoning these difficulties are not so apt to arise, since the diagnosis can usually be made with a sufficient degree of certainty. In the subacute cases, however, and those presenting a suggestive but rather vague and indefinite symptom-complex, the difficulties of diagnosis on the basis of the clinical picture alone are obviously very great. In the case of such symptoms as constipation, severe headache, or abdominal pain, as a result of which a worker may claim that he is unable to work, lead may or may not be the etiologic factor. Nevertheless, the compensation courts are continually faced with the necessity for making a definite decision in these doubtful cases.

In the present series of examinations, the diagnosis of lead absorption in cases of this type was confirmed by the laboratory in approximately two-thirds of the cases. In other words, the probability that lead exposure is the cause of a suggestive symptom-complex would appear to be approximately two to one. It might properly be argued, therefore, that if careful laboratory tests were made in all cases of this type approximately two-thirds of the cases which are so perplexing at the present time would be readily disposed of. On the other hand, it must be remembered, of course, that even where laboratory evidences of active lead absorption can definitely be established, the symptom-complex may nevertheless be due to other causes. An assumption that such an etiologic relationship probably exists would, however, seem to be warranted. Compensation would be justified in these cases and the worker very properly given

the benefit of what slight doubt must exist at all times.

In approximately one-third of the cases no laboratory confirmation of the clinical picture was found. In these cases while, of course, there is again a chance of error in that the laboratory cannot be regarded as infallible, nevertheless it would seem fair to say that the presumption of evidence is rather against an etiologic relationship between the symptom-complex and lead absorption. If compensation were withheld in these cases, the making of repeated laboratory tests by the physician in charge of the case would automatically be stimulated, thereby reducing still further the chances of error in diagnosis.

Unfortunately, at the present time laboratory evidence is rarely available as an aid to the diagnosis of these cases when they come up for compensation because physicians are not in the habit of making the necessary tests when the case first comes to them for treatment. Frequently in difficult cases it is attempted to make the tests at the time the case is being considered by the court. This procedure is usually a failure, however, because such a long interval has elapsed since the illness that positive tests are usually no longer to be expected. For several years the New York State Bureau of Industrial Hygiene has offered to make the necessary tests for physicians at cost, but for some reason they have not availed themselves of this offer.

If physicians could be persuaded to prepare their cases fully by making the necessary laboratory tests of blood and urine in every case of suspected lead poisoning, it is believed on the basis of the present experience that about two-thirds of the troublesome cases could very probably be disposed of with greater justice to the workers and with considerably less expenditure of time by the compensation courts; the presence of laboratory evidence of active lead absorption being regarded as presumptive evidence in favor of lead as the etiologic cause of the disability. In about a third of the cases the absence of laboratory confirmation would still leave the diagnosis somewhat in doubt, but it is believed that the presumption would rather be against lead exposure as the etiologic factor. Even taking into account the fact that a certain number of errors must inevitably occur, these would be relatively small in number if laboratory evidences of lead absorption were available to the compensation courts to supplement the clinical picture in all cases presented to them.

BIBLIOGRAPHY

1. Aub, J. C., Fairhall, L. T., Minot, A. S., and Reznikoff, P.: Lead Poisoning. Medicine, 1925, *4*, 1; Medicine Monographs, Vol. VII. Baltimore, The Williams & Wilkins Co., 1926.

2. Collis, E. L.: Special Report on Dangerous or Injurious Processes in the Smelting of Materials Containing Lead. [Cmd. 5152.] London, H. M. Stationery Office, 1910.

3. ENGEL, H., AND FROBOESE, V.: Untersuchungen zur Klärung der Bleiverflüchtigung beim homogenen Verbleien und Bleilöten unter Verwendung verschiedener Gebläseflammen. Arch. f. Hyg., 1925–1926, *96*, 69; abstr. in THIS JOUR., 1926, *8*, 86.

4. LINENTHAL, H.: Early Diagnosis of Lead Poisoning. Diseases of Occupation and Vocational Hygiene by G. M. Kober and W. C. Hanson. Philadelphia, P. Blakiston's Son & Co., 1916, p. 96. Industrial Health by G. M. Kober and E. R. Hayhurst. Philadelphia, P. Blakiston's Son & Co., 1924, p. 433.

5. MAYERS, M. R.: Lead Anemia. THIS JOUR., 1926, *8*, 222.

6. MAYERS, M. R.: A Study of the Lead Line, Arteriosclerosis, and Hypertension in 381 Lead Workers. *Ibid.*, 1927, *9*, 239.

7. SMITH, S. A.: Some Aspects of Lead Absorption. Med. Jour. Australia, 1925, *2*, 391.

8. TELEKY, L.: Bleivergiftung. Schrift. a. d. Gesamtgeb. d. Gewerbehyg., N. S. No. 5. Berlin, Julius Springer, 1919, p. 1. Cited in (1, p. 198).

BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers and as space permits.

GRUNDRISS DER GESUNDHEITSGESETZGEBUNG UND DER GESUNDHEITSFÜRSORGE, einschliesslich der Sozialversicherung, für männliche und weibliche in der Wohlfahrtspflege tätige Personen, insbesondere Wohlfahrtspflegerinnen, Gemeindeschwestern, ferner für den Gebrauch an Wohlfahrtsschulen, pädagogischen Akademien und Volkshochschulen. By Med.-Rat Dr. *R. Engelsmann*, Kreisarzt des Stadtkreises Kiel. Paper. Pp. viii, 163 with index. Berlin: Julius Springer, 1929.

PUBLIC HEALTH AND HYGIENE. A STUDENTS' MANUAL. By *Charles Frederick Bolduan*, M.D., Director, Bureau of Health Education, Department of Health, City of New York; Surgeon (R) U. S. Public Health Service; Formerly Lecturer, Preventive Medicine and Public Health, College of Physicians and Surgeons, Columbia University, New York. Cloth. Pp. 312 with illustrations and index. Philadelphia and London: W. B. Saunders Co., 1929.